

# ESA/ESOC

## Navigation Support Office

Contributing as AC to:



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## **The Navigation Support Office**

- **Is a ILRS AC**
- **Provides orbit predictions to the ILRS for:**
  - **LEO's**  
(Flight dynamics)
  - **GNSS satellites (Galileo)**  
Navigation Support Office in the frame of its Galileo Geodetic Reference Frame activities (TGVF Contract)

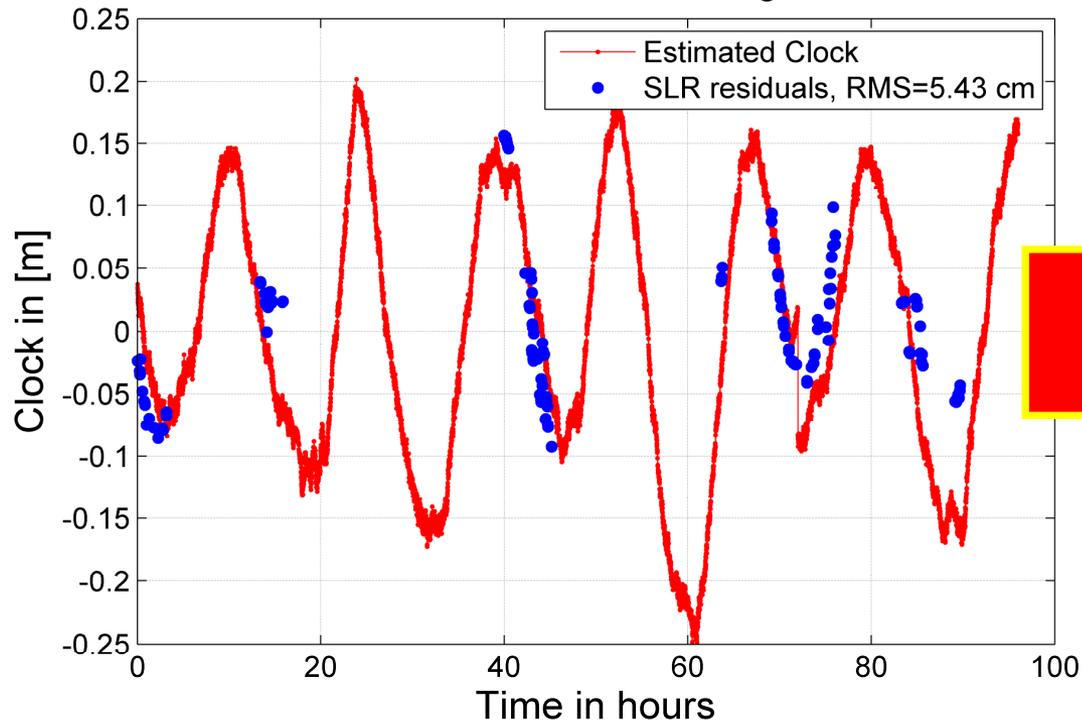
## Laser ranging observations are used for:

- **Orbit predictions**
  - As backup solution OVF
- **Satellite orbit, clock and model validations**
  - Routinely in OVF

# Examples for the Application of SLR observations at ESA/ESOC

SLR Residuals and Estimated GIOVE-B Clock Parameters (30 s)

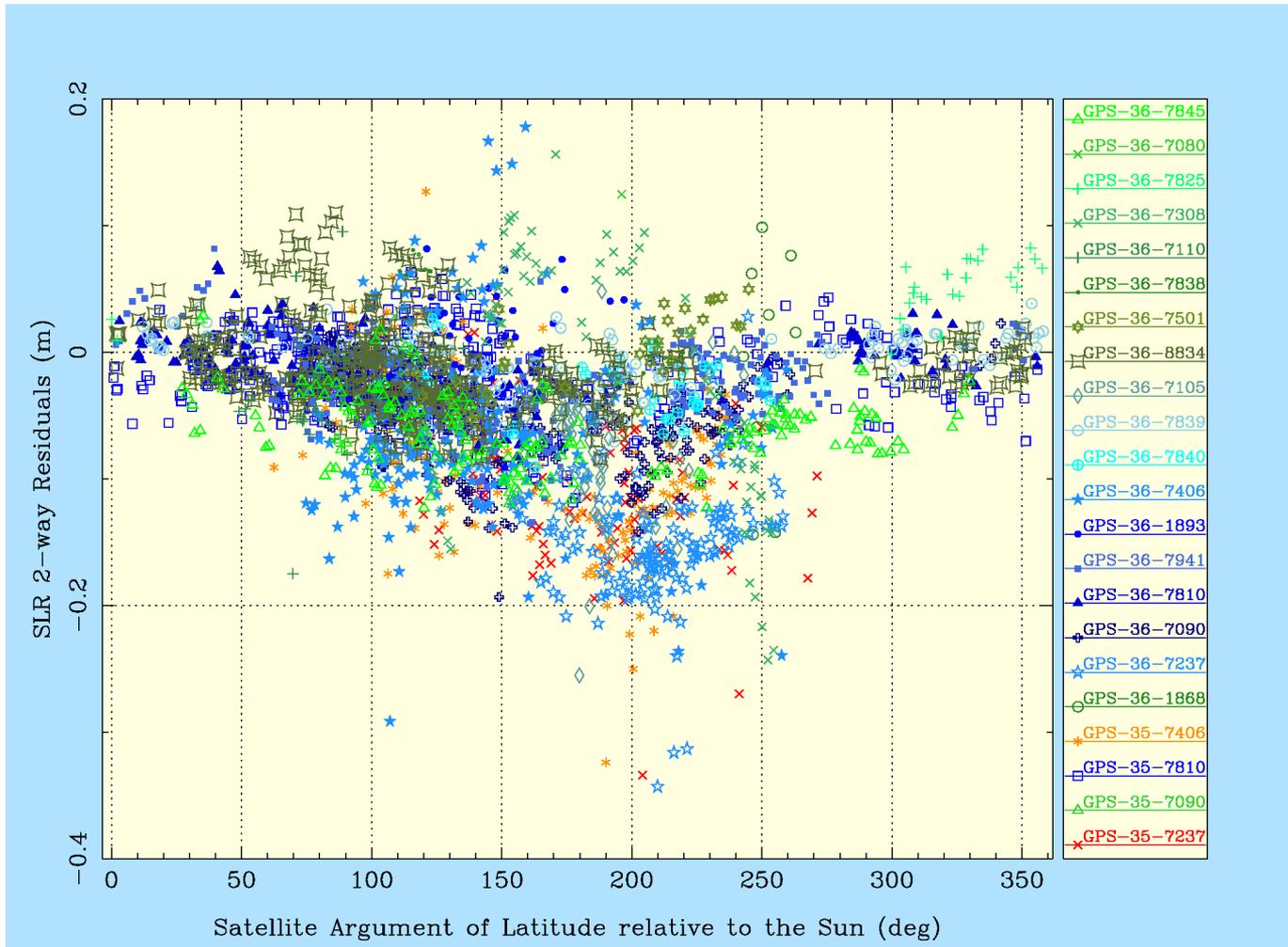
GIOVE-B Clock After Removing Clock Drift



GIOVE-B clock maps the radial orbit error!!!

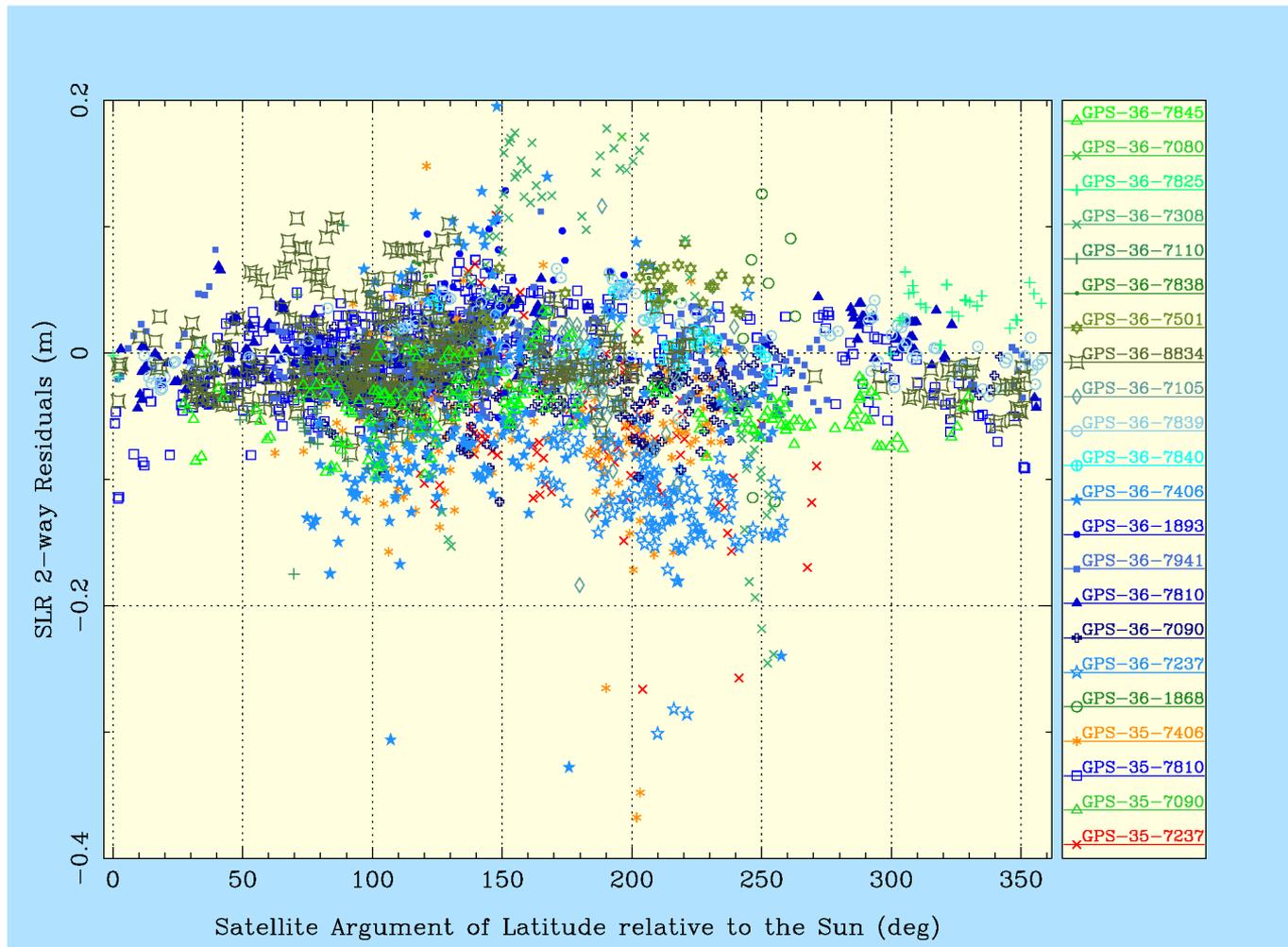
Agreement GIOVE-B clock and SLR is fantastic (a few cm)!!!

# Examples for the Application of SLR observations at ESA/ESOC



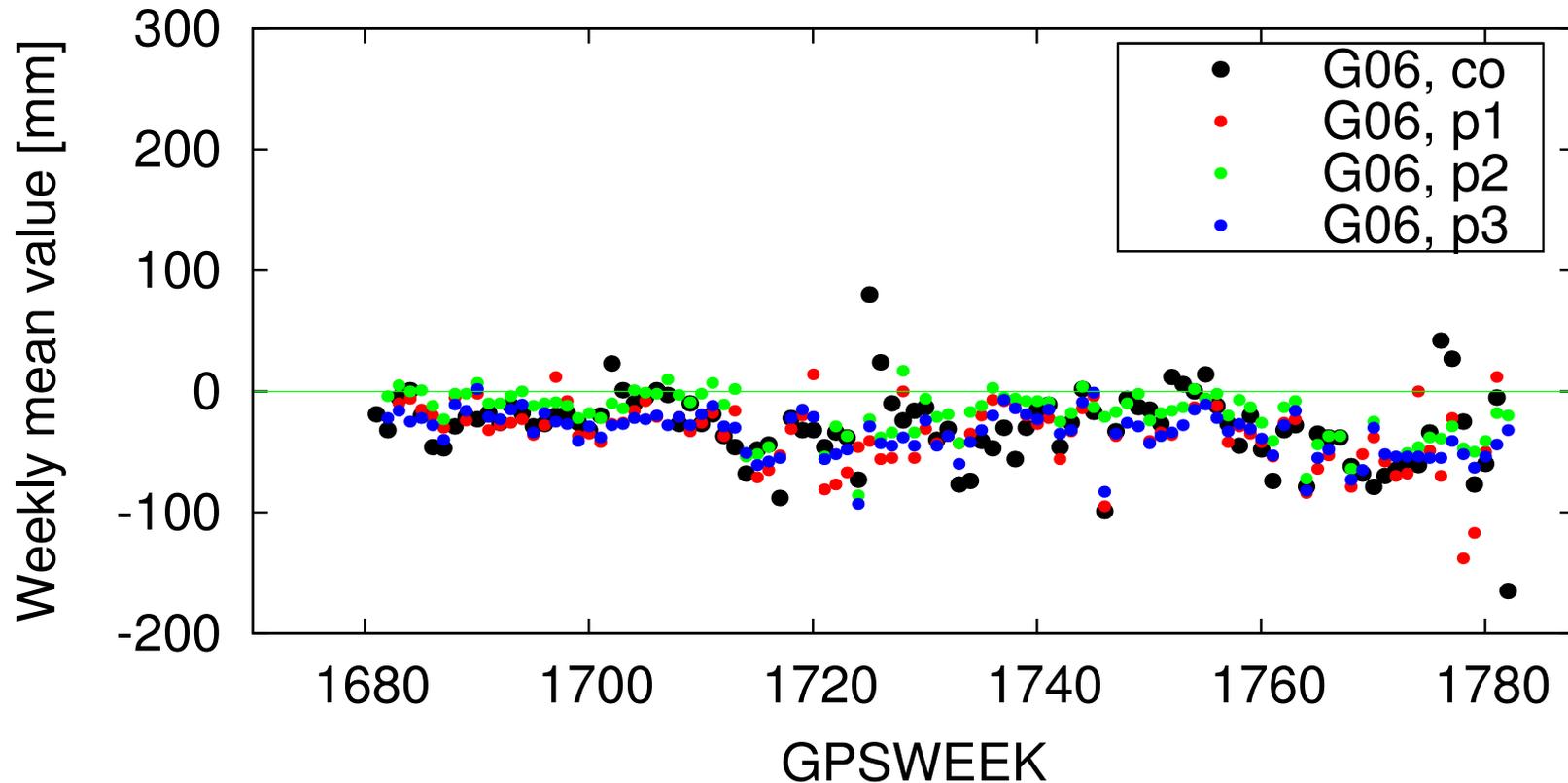
**SLR 2-way Residuals (no Box-Wing model used)**

# Examples for the Application of SLR observations at ESA/ESOC



**SLR 2-way Residuals (Box-Wing model used)**

# Examples for the Application of SLR observations at ESA/ESOC



## Routine monitoring of orbit product accuracy

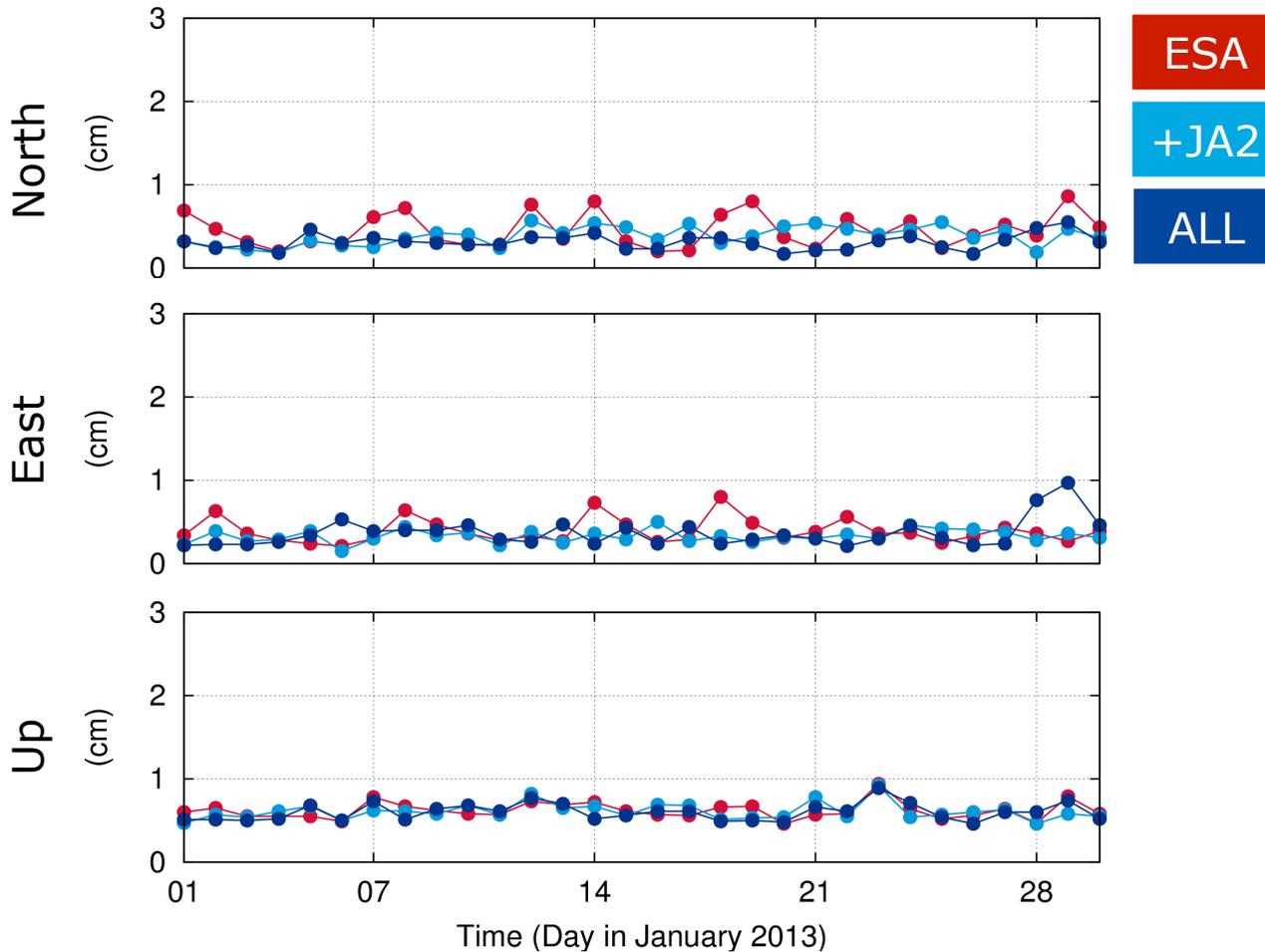
# Combination of satellite-geodetic techniques at ESA/ESOC



Altitude (km)	Incl. (deg)	#	Satellite	GNSS	DORIS	SLR	
~ 20200	~ 56	31	GPS	G		S	ESA
~ 19100	~ 65	23	GLONASS	G		S	+JA2
~ 19100	~ 65	2	Etalon-1/2			S	ALL
~ 5900	~ 52/110	2	Lageos-1/2			S	ESA
~ 1340	~ 66	1	Jason-2	G	D	S	
~ 971	~ 99	1	HY-2A		D		
~ 830	~ 99	2	Spot-4/5		D		
~ 717	~ 92	1	CryoSat-2		D	S	

# GPS station repeatability

... of daily solutions – without Helmert transformation



Mean RMS (STD)

0.45 ( $\pm 0.20$ )

0.39 ( $\pm 0.11$ )

0.33 ( $\pm 0.11$ )

0.39 ( $\pm 0.15$ )

0.33 ( $\pm 0.08$ )

0.37 ( $\pm 0.14$ )

0.62 ( $\pm 0.10$ )

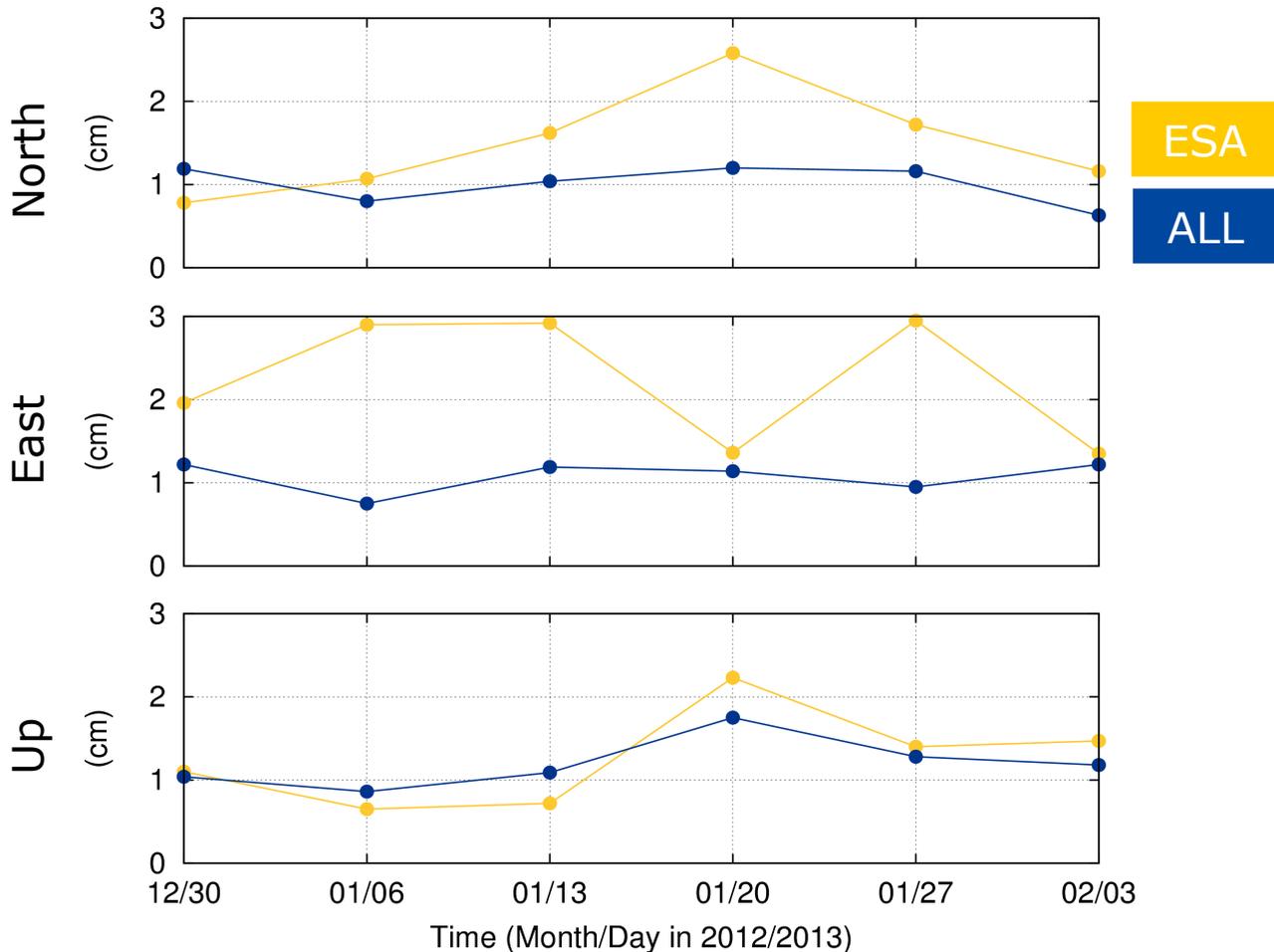
0.61 ( $\pm 0.10$ )

0.60 ( $\pm 0.10$ )

Unit: cm

# SLR station repeatability

## ... of weekly solutions



Mean RMS (STD)

1.49 ( $\pm 0.64$ )

1.00 ( $\pm 0.24$ )

2.24 ( $\pm 0.78$ )

1.08 ( $\pm 0.19$ )

1.26 ( $\pm 0.58$ )

1.20 ( $\pm 0.30$ )

Unit: cm

## Increasing number of Satellites with SLR reflectors

- **How to optimise SLR tracking?**
  - Number and distribution of normal points per passage?
  - How many normal point per orbit are required?
  - Geographical distribution of normal points?
  - Which satellites should be tracked?

**ESA/ESOC is organising a dedicated POD conference at ESOC, Darmstadt, Germany in May 2015 (TBC). Details will be announced in June 2014. The POD conference will cover all areas of POD, including:**

- **Constellations and orbits**

GNSS, LEO, MEO, GTO, GEO

- **Techniques**

GNSS, Satellite Laser Ranging, Doris, Radar Altimetry

- **Algorithms and models**

Force models, Data processing, Optimisation, ...

- **Hardware and Processing concepts**

Onboard Receivers, Real Time, Batch processing ...

- **Interaction between different POD stake holders**

Service providers, System providers, Science community, End Users,...

European Space Agency